

# SAND-DUNE TIGER BEETLES OF NORTHERN NEW ZEALAND COASTS (COLEOPTERA: CICINDELIDAE)

K. A. J. WISE

AUCKLAND INSTITUTE AND MUSEUM

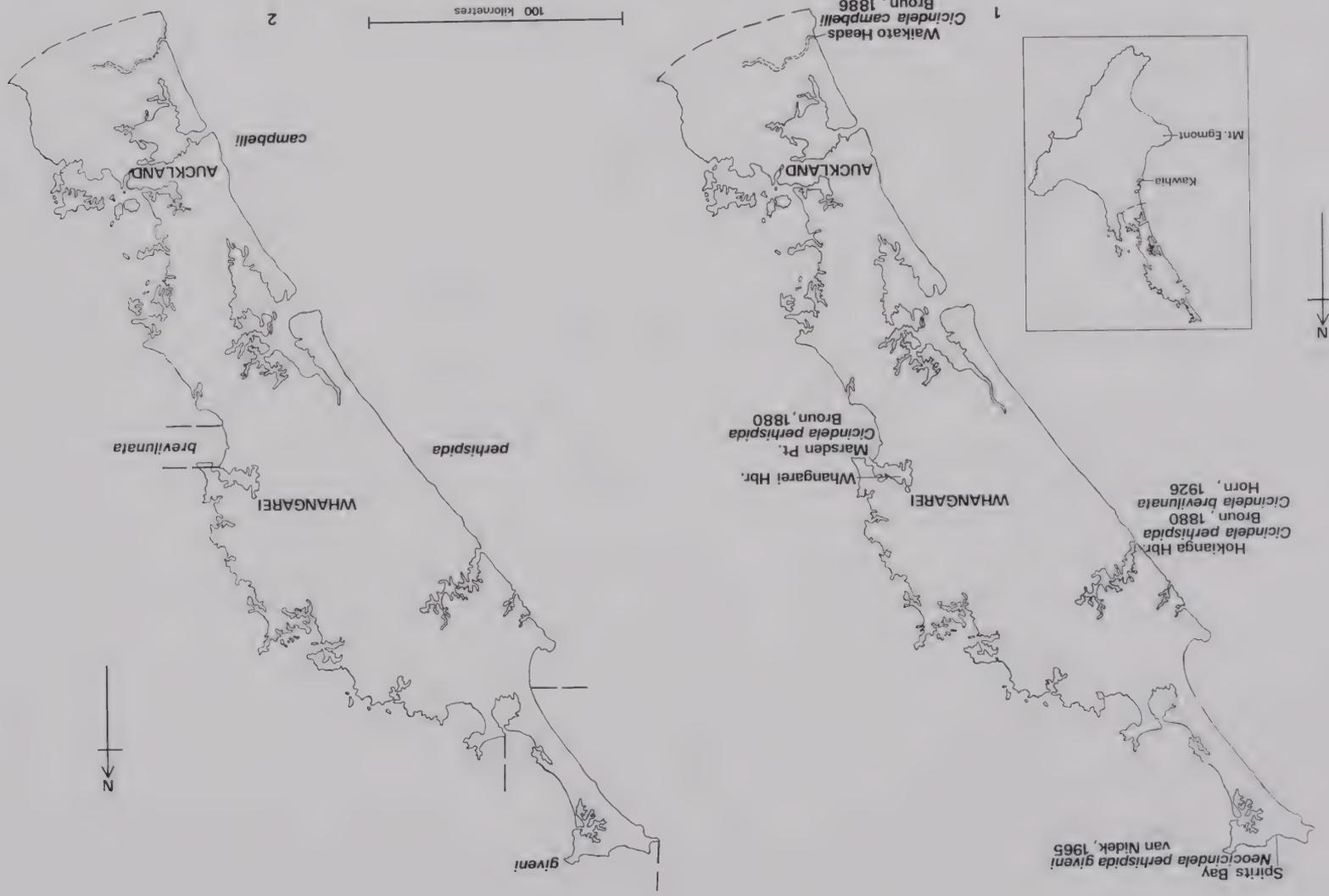
*Abstract.* This study of coastal tiger beetles was initiated to consider the occurrence of colour patterns on various sand colours. Historical records are included together with current collections around the northern coasts of the North Island.

Early records are confused but current collections show that, in the species currently accepted as *Neocicindela perhispidata* (Broun, 1880), three previously described subspecies, *Neocicindela perhispidata campbelli* (Broun, 1886) on black ironsands on the more southern west coast, *N.p. perhispidata* (Broun, 1880) on grey to cream sands on the northern west coast and *N.p. giveni* van Nidek, 1965 on very pale cream and glistening white sands in the far north, are one continuous series with the *campbelli-perhispidata* change zone along Muriwai Beach and the *perhispidata-giveni* along Ninety Mile Beach further north. Another species *Neocicindela brevilunata* (Horn, 1926) is found to be confined to the east coast south of Whangarei Hbr., from Marsden Pt. south to Pakiri on greyish-white sand-dunes. Differences in sand colour and composition are shown to correspond with differences in the distribution of coastal tiger beetles. Local and seasonal activity of these beetles are noted, colour and elytral colour patterns are described and the consideration of species and subspecies is discussed.

Synonymic lists are provided for the two species together with details of specimens of the coastal tiger beetles in some overseas museums. The published records are compared. The results of these findings are discussed and compared with original descriptions of the two species elytral patterns which are shown to be two descriptions of the same species.

Coastal sand-dune tiger beetles have been known in the northern half of the North Island of New Zealand (Fig. 1) since T. Broun (1880) described *Cicindela perhispidata* which he recorded from Hokianga and Marsden Point. Broun (1886) also described *Cicindela campbelli* from the Waikato Heads. A third species, *Cicindela brevilunata* was described by W. Horn (1926b) who recorded one specimen from Hokianga. Later, E. Rivalier (1963) described a new genus, *Neocicindela*, for all New Zealand species of Cicindelidae and, subsequently, C.M.C.B. van Nidek (1965) described *Neocicindela perhispidata giveni* as a new subspecies from Spirits Bay. The distribution of these original localities are shown on the accompanying map (Fig. 1).

The present study originated when the author became aware from his own collecting (in the 1960s and 1970s) that the various elytral colours and patterns of the



Figs. 1, 2. Maps. 1. Northern North I showing original localities recorded for described species and subspecies of coastal tiger beetles. Inset. North I, New Zealand. 2. Actual distribution of described species and subspecies of coastal tiger beetles from specimens collected for Auckland Museum, 1967-1980.

coastal sand-dune tiger beetles were related to the colours of the sands in different areas.

In general (see Figs. 2, 3-10), dark specimens similar to those described as *Cicindela campbelli* Broun, 1886, occurred on the black ironsands of the west coast beaches near Auckland and further south. The species accepted as *Cicindela perhispidata* Broun, 1880, with reduced thin dark areas on the elytra, was from further north on the west coast cream sands and the subspecies *Neocicindela perhispidata giveni* van Nidek, 1965, with dark areas almost completely reduced was on pale sands of the northernmost and eastern beaches of the far north. *Cicindela brevilunata* Horn, 1926, with bold but reduced dark areas, occurred on whitish sands south of the Whangarei Harbour on the east coast. Pinkish-brown sand on the intervening north-eastern coasts did not provide tiger beetles.

Further, because of apparent mis-labelling and/or mis-recording, there had been a confusion of the species names and localities in earlier years in regard to the *perhispidata* of Broun (1880) occurring at Hokianga (on the west coast) and Marsden Point (south of Whangarei Harbour on the east coast) and to *brevilunata* of Horn (1926b) also occurring at Hokianga. Both Hudson (1935) and Horn (1936) had continued this confusion. Because neither Broun (1880) nor Horn (1926b) designated type specimens in their papers and because Horn (1936) recorded having a Hokianga specimen taken from Broun's collection in the British Museum there was a distinct possibility that the names of the two species could be exchanged. Consequently it was deemed necessary by the author to consider the taxonomic position of these two species which would require examination of types and other specimens in overseas museums. Subsequently this was done in 1987. Further collecting started in January 1988, during the 1987-88 summer season, has revealed further distributional and seasonal information for the entities concerned. The results of these studies are reported here.

## HISTORICAL RECORDS

### *Biographical notes*

This list starts with Capt. Thomas Broun who studied New Zealand beetles for at least 45 years and published extensively. Two people who follow (Cheeseman and Campbell) are credited by Broun with collecting early specimens he described. The next four persons were later Broun contemporaries who also collected coastal tiger beetles and the last three were later collectors.

Thomas Broun (1838-1919) was a professional soldier when he first arrived in New Zealand. Later he was both an amateur coleopterist and professional entomologist as well as a farmer and a schoolteacher. His first published paper on New Zealand Coleoptera was read before the Auckland Institute in May 1875, and many more followed.

Broun apparently started teaching (at Tairua, east of Auckland) in 1876 (Cheeseman 1920) and he moved to the Whangarei Heads area (on the northern side of Whangarei Hbr.) in 1877 (Broun MS. letters in Auckland Museum library). As the printing of his Manual (Broun 1880) had been authorised in 1877 (Hector 1880), he



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Figs. 3-6. *Neocicindela* spp. Male. 3. *N. perhispida* "campbelli". Waikato R. Heads. 4.IV.1988. 4. *N. perhispida* "perhispida". Mitimiti, N. of Hokianga Hbr. Heads. 4.II.1988. 5. *N. perhispida* "giveni". Kapowairua, Spirits Bay. 23.II.1988. 6. *N. brevilunata*. Marsden Pt. 26.II.1988.



Figs. 7-10. *Neocicindela* spp. Female. 7. *N. perhispida* "campbelli". Waikato R. Heads. 4.IV.1988. 8. *N. perhispida* "perhispida". Mitimiti, N. of Hokianga Hbr. Heads. 4.II.1988. 9. *N. perhispida* "giveni". Kapowairua, Spirits Bay. 23.II.1988. 10. *N. brevilunata*. Marsden Pt. 26.II.1988.

was actively engaged on species descriptions there. He moved to Kawau Island early in 1879 and completed his manuscript there (Broun MS. letters). The main Broun Collection of New Zealand Coleoptera is in British Museum (Natural History) Entomology, London, with a smaller duplicate collection in Entomology Division, D.S.I.R., Auckland.

T.F. Cheeseman, credited by Broun (1880) with the collection of a Hokianga (west coast) specimen, was principally a botanist. He was appointed Curator of the Auckland Museum in 1874. His original notebooks in the library of this museum have been searched but no indication that he visited the west coast Hokianga area prior to 1880 has been found although he collected in the Whangarei area several times. There are also no plant collections by Cheeseman from Hokianga or that area of coast in the Cheeseman Herbarium. Cheeseman (1920) later wrote an obituary for Thomas Broun in which he mentioned first meeting Broun in 1875.

A certain W.D. Campbell Assoc.Inst.C.E. published several papers on beaches, zoology and geology in the *Transactions of the New Zealand Institute* between 1877 and 1883. The last three were read to the Auckland Institute in 1881 and 1882 so he could well have been the collector of the Waikato Heads specimens of *Cicindela campbelli* Broun, 1886. Campbell may have had direct contact with Broun or indirect through Cheeseman.

Later contemporaries were A.E. Brookes (1876-1955) an amateur conchologist and coleopterist of Auckland (in later life) and E.R. Fairburn (1890-1982) an amateur coleopterist of Whangarei. The Brookes Collection is now in Entomology Division, D.S.I.R., Auckland and the Fairburn Collection is now in the Northland Regional Museum, Whangarei. Brookes and Fairburn both collected tiger beetles at Ruakaka beach on 25 March 1932.

C.E. Clarke, another contemporary amateur entomologist lived at Dunedin in the South Island before he moved to Auckland in the 1920s. After presenting his general collection, including Coleoptera, to the Auckland Museum in 1929, he built up a second Coleoptera collection which was divided between Auckland Museum and British Museum (National History) in the 1950s.

A further contemporary was Arthur Richardson (1881-1963), a general collector of South Auckland, who collected insects occasionally and exchanged specimens with the others. His private museum including insects was sold privately but all his coastal tiger beetle specimens are in other collections. He collected on Ninety Mile Beach with C.E. Clarke on 11 January 1927.

E.D. Pritchard, of Auckland, who is not so well-known amongst New Zealand amateur entomologists, has collected (mainly beetles and springtails) in the North Island since 1938. His collections, now in the Auckland Museum, include several series of coastal tiger beetles from the northern North I.

B.B. Given (now retired) and the late R.A. Cumber were both professional entomologists (of Entomology Division, D.S.I.R.) who were together on a field trip to Spirits Bay when they collected coastal tiger beetles there in January 1957.

*Collections and published records*

In his *Manual of New Zealand Coleoptera*, Broun (1880) published a description of *Cicindela perhispidata* as his species number "9". Broun stated that he was indebted to T.F. Cheeseman (then Botanist of the Auckland Museum) for a specimen which he found near Hokianga (which is on the northern west coast) and added "I found a few others on the loose white sand at Marsden Point, Whangarei Harbour" (which is on the northern east coast). This was the beginning of a confusion which has lasted ever since.

Another species, *Cicindela campbelli*, was described by Broun (1886) as his number "1451" from three "terribly mutilated" specimens "caught at Waikato Heads" (which is on the west coast south of Auckland) by W.D. Campbell.

W. Horn (1892) described a variety of *Cicindela perhispidata* Broun (without naming it), from a specimen in the Vienna Museum collections. In his catalogue of Cicindelidae, E. Fleutiaux (1892) listed the New Zealand species of *Cicindela* including *perhispidata* Broun and *campbelli* Broun.

W. Horn (1893) suggested that *Cicindela perhispidata* and *C. campbelli* could be varieties of one species, and he named his 1892 variety of *perhispidata* as var. *brouni*. However, Horn (1896), having seen Broun specimens of *C. campbelli* in the C.A. Dohrn collection, synonymised his variety *brouni* with that species.

J.J. Walker (1904) recorded *Cicindela perhispidata* Broun from coastal sand-dunes west of "Woodhills", on the west coast north of Auckland. This is Woodhill, south of the Kaipara Harbour. Some 5.6-6.4 km distant to the west is Muriwai Beach, at ca. 8.5 - 10.7 km north of Muriwai, which Walker reached. F.W. Hutton (1904) listed *Cicindela perhispidata* Broun and *C. campbelli* Broun in his *Index Faunae Novae Zealandiae*, as did G.V. Hudson (1923).

In the *Genera Insectorum*, W. Horn (1915) included the New Zealand species of Cicindelidae recording *Cicindela perhispidata* Broun, 1880 and *C. campbelli* Broun, 1886 with Horn's own previous records of *perhispidata* var. (1892) and var. *brouni* (1893, 1896) as synonyms of *campbelli*. There is also a figure, on a colour plate, named *Cicindela perhispidata* but which clearly has the colour pattern of his later-named species *C. brevilunata* Horn, 1926. In the *Coleopterorum Catalogus*, W. Horn (1926a) listed *Cicindela campbelli* Broun, 1880, with the same synonymy, and *C. perhispidata* Broun, 1880.

W. Horn (1926b) also described *Cicindela brevilunata*, with his above-mentioned figure name of *Cicindela perhispidata* (Horn 1915) as a synonym. Unfortunately, two of the three recorded specimens were without locality and the third was a specimen, previously in the British Museum collection, labelled "Hokianga". This area is on the northern west coast while the form described and figured (Horn 1915) is the east coast form.

In his book on New Zealand Coleoptera, G.V. Hudson (1934) gave a description of the *Cicindela perhispidata* elytral markings and previous locality records. The systematic index included *C. perhispidata* Broun and *C. campbelli* Broun.

W. Horn (1936) again recorded the three known northern coastal forms of *Cicindela* but placed *campbelli* as a subspecies of *perhispidata*. He gave additional locality records, repeated the Hokianga-Marsden Point confusion, and mentioned the Hokianga specimen of *C. brevilunata* (Horn 1926b) now in his collection from the Broun collection in the British Museum.

In a note under the heading of *Cicindela brevilunata*, A.E. Brookes (1944) pointed out that this species is an east coast species and that *C. perhispidata* is a west coast species. He queried the earlier confusion of localities, particularly a statement by Horn (1936), and made other comments.

E. Rivalier (1963, 1964) described a new genus *Neocicindela* for all New Zealand species. Subsequently, C.M.C. Brouerius van Nidek (1965) listed the species of *Neocicindela* Rivalier, 1963 and included *N. brevilunata* and *N. perhispidata*. For the latter, he recognised the subspecies *perhispidata perhispidata* and *perhispidata campbelli*, and described a third subspecies *perhispidata giveni* from Spirits Bay (which is on the far northern coast of Northland).

In a catalogue of types held in the former Deutsches Entomologisches Institut, H. Döbler (1973) listed "*brevilunata* Horn, 1926 (*Cicindela*)" with the three syntypes recorded by Horn (1926b) and the two of these in the DEI collection. Also listed was "*brouni* Horn, 1893 (*Cicindela*)" (a variety of *perhispidata* synonymised with *campbelli* by Horn 1896) with one syntype in the DEI collection. The Deutsches Entomologisches Institut of Berlin was moved to Eberswalde in 1964 and was re-named as the Abteilung Taxonomie der Insekten of the Institut für Pflanzenschutzforschung, Eberswalde, D.D.R. (East Germany), in 1970.

#### RECENT COLLECTIONS, SAND-DUNES AND SAND

##### *Coastal sand-dune collections*

Localities collected by the author since the 1960s (see Fig. 11) are listed in order from south to north up the west coast and southwards down the east coast in Table 1. Specimen elytral marks (see Figs. 12-51) and colours are compared with visible sand colours and composition. Colours given are comparative, there is a range of intervening shades. There is also a wide range of variation in the elytral dark marks and colour pattern, particularly through the west coast to far north series (the *campbelli-perhispidata-giveni* patterns).

No secondary sexual characters have been noticed. Elytral colour patterns of males and females appear to fall within the overall range of variation. Larger individuals (often females) may give the impression of thicker dark marks but this is a matter of size. The key comparison is between the dark marks and the pale colour markings on each specimen. The thicker and thinner dark marks recorded here are visible on individuals of both sexes and all sizes.

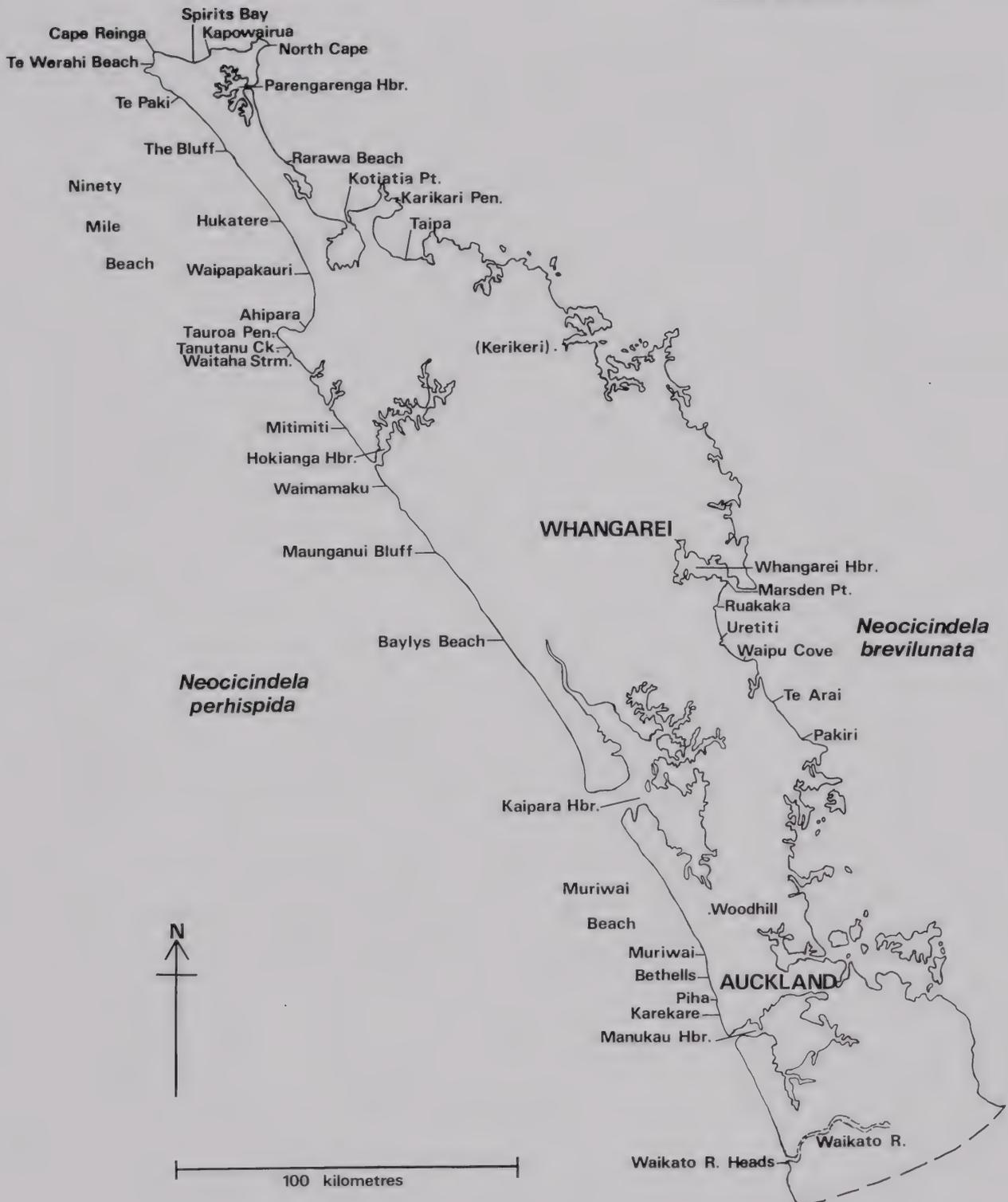


Fig. 11. Map. Northern North I. Localities for the two coastal tiger beetle species *Neocicindela perhispidata* (Broun, 1880) and *N. brevilunata* (Horn, 1926), with other mentioned features. See also Fig. 1 inset.

Table 1. Elytral markings and colour of coastal tiger beetles, *Neocicindela perhispidata* (Broun, 1880) and *N. brevilunata* (Horn, 1926), in collections from the northern North I, with sand colours.

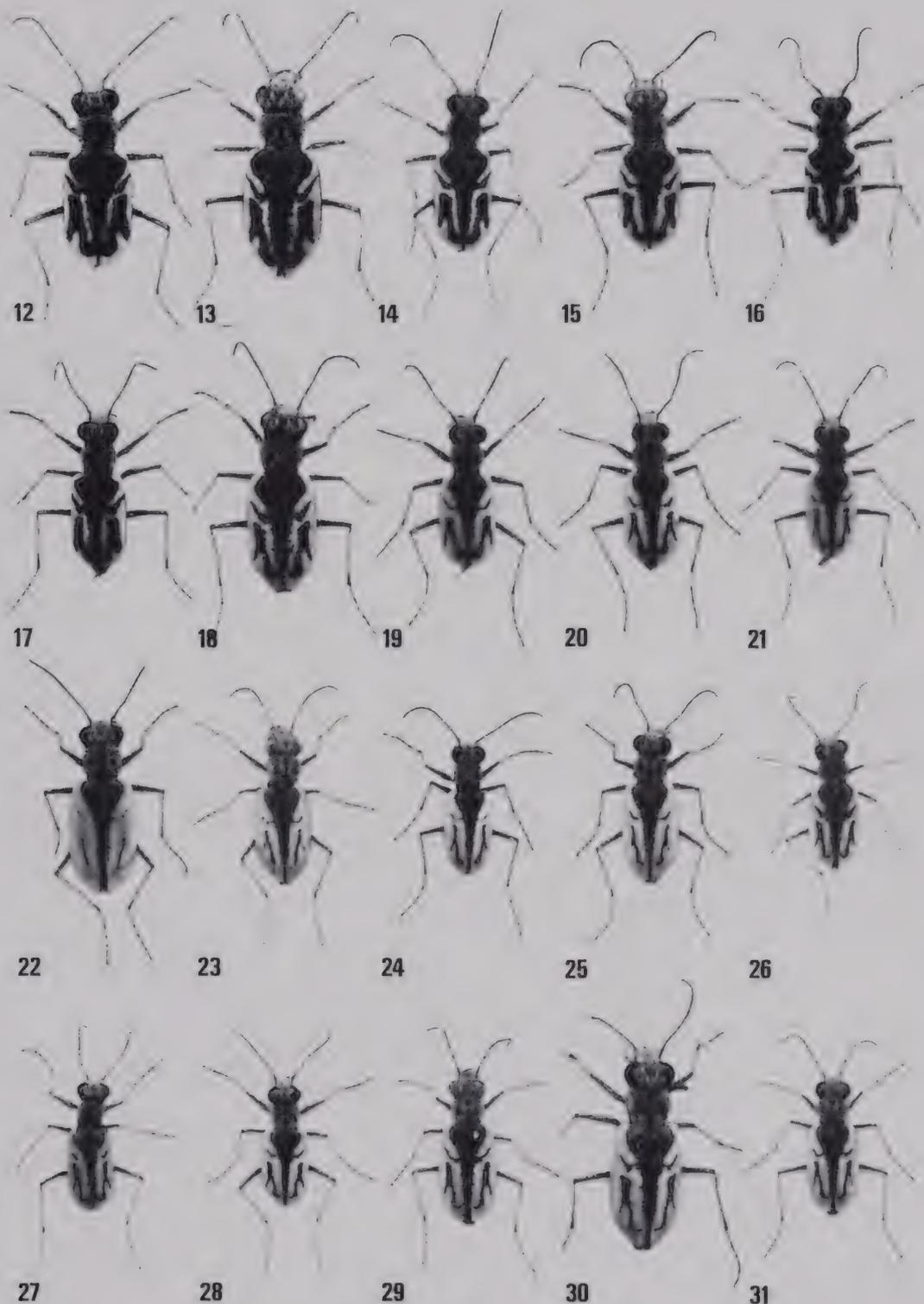
Locality	Date & No. of specimens	Specimen elytral markings		Sand samples
		Dark background marks	Colour	
<i>N. perhispidata</i> (Broun, 1880)				
Beach W. of Kawhia	18.III.1982 -3	Thick with thick lateral edges	Yellowish	Dark ironsands
Beach S. side Waikato R. Heads	4.IV.1988 -10	Thick	Dark cream	Dark ironsands
Beach Karekare	1.II.1988 -4	Thick, 1 with thick lateral edges	Dark cream	Dark ironsands
Beach Bethells	1.IV.1969 -9	Thick	Dark cream	Dark ironsands
S. end Muriwai Beach, Muriwai	25.I.1988 -4	Thick, 2 part thin	Dark cream	Dark ironsands
Muriwai Beach, 2.1km N. of Muriwai	5.IV.1988 -1	Thinner	Cream	Dark ironsands
Muriwai Beach, 3.6km N. of Muriwai	31.III.1988- 1	Thick	Cream	
Muriwai Beach, 4.7km N. of Muriwai	31.III.1988 -1	Thick	Cream	Dark ironsands
Muriwai Beach, 6.2km N. of Muriwai	31.III.1988 -2	Thick	Cream	Dark ironsands
Muriwai Beach, 7.6km N. of Muriwai	31.III.1982 -2	Thick	Cream	Dark ironsands
Muriwai Beach, 9.1km N. of Muriwai	5.IV.1988 -1	Thinner	Cream	Dark ironsands
Muriwai Beach, 10.1km N. of Muriwai	5.IV.1988 -2	1 thick 1 thin	Cream	
Muriwai Beach, 11.4km N. of Muriwai	5.IV.1988 -8	3 thick 5 thin	Cream	Dark
Muriwai Beach, 12.3km N. of Muriwai	31.III.1988 -5	1 part thick 4 thin	Cream	Dark-dark grey
Muriwai Beach, 16.4km N. of Muriwai	31.III.1988 -2	Thin	Cream	Dark grey
Muriwai Beach, 19.3km N. of Muriwai	16.III.1988 -8	Thin	Cream	Dark grey
Beach S. of Chases Gorge, Baylys Beach	31.I.1973 -5	Thin		Dark cream
	13.IV.1988 -1	Thin	Cream	Dark cream
Aranga Beach, S. of Maunganui Bluff	11.III.1976 -5	Thin	Cream	Dark cream
Beach Waimamaku, S. of Hokianga Hbr.	5.II.1988 -17	10 thin 7 thin, reduced	1 dark cream 16 cream-pale whitish cream	Cream, whitish cream (coarse)
Beach S. end Mitimiti, N. of Hokianga Hbr.	4.II.1988 -12	9 very thin 3 very thin, reduced	1 dark cream 11 cream-pale cream	(Pale cream)

Beach N. end Mitimiti, N. of Hokianga Hbr.	4.II.1988	-8	6 very thin 2 very thin, reduced	1 Dark cream 7 Cream-pale cream	Pale cream
Beach at Waitaha Strm, S. of Tauroa Pen.	9.II.1988	-27	6 very thin 21 reduced	Cream-very pale cream (some discoloured)	Pale cream
Beach at Tanutanu Ck., S. of Tauroa Pen.	16.II.1983	-2	Very thin, part reduced	Pale cream	Pale cream
	13.XII.1985	-1	Very thin, part reduced		
Ninety Mile Beach, Ahipara	1.II.1973	-5	Thin	Cream	Dark cream
	13.I.1988	-4	3 thin 1 thin, part reduced	3 cream, 1 dark cream	
	8.II.1988	-8	Thin	7 cream, 1 dark cream	Dark cream
	26.III.1988	-1	Thin	Cream	Dark cream
Ninety Mile Beach, Waipapakauri	7.III.1978	-1	Thin	Cream	
	27.II.1984	-4	Thin	Cream	Dark cream
	26.III.1988	-2	Thin	Cream	Dark cream
Ninety Mile Beach, Hukatere	14.I.1988	-9	Thin — very thin	Cream	Dark cream
	25.II.1988	-16	14 thin 2 thin, reduced	Cream	Dark Cream
On yellow sand in forest clearing ca. 3.6km from beach, Hukatere	25.III.1988	-1	Thin	Yellowish-cream	Yellow
Ninety Mile Beach, 4.2km N. of Hukatere	23.III.1988	-6	1 thin 5 very thin	Pale cream	Dark cream
Ninety Mile Beach, 8.7km N. of Hukatere	24.III.1988	-3	1 thin 2 very thin	Pale cream	Dark cream
Ninety Mile Beach, 15.0km N. of Hukatere	24.III.1988	-2	2 very thin	Cream	Dark cream
Ninety Mile Beach, 15.8km N. of Hukatere	25.III.1988	-3	Thin — very thin	Cream	Dark cream
Ninety Mile Beach, 17.2km N. of Hukatere	25.III.1988	-5	1 thin 3 very thin	Pale cream	Dark cream
			1 very thin, part reduced		
Ninety Mile Beach, 18.4km N. of Hukatere	25.III.1988	-2	1 very thin, 1 very thin, part reduced	Pale cream	Dark cream
Ninety Mile Beach, 19.8km N. of Hukatere	24.III.1988	-4	1 very thin 2 very thin, reduced	Pale cream	Dark cream
			1 very thin, part reduced		
Ninety Mile Beach, 20.5km N. of Hukatere	25.III.1988	-1	Very thin, reduced	Pale cream	Cream

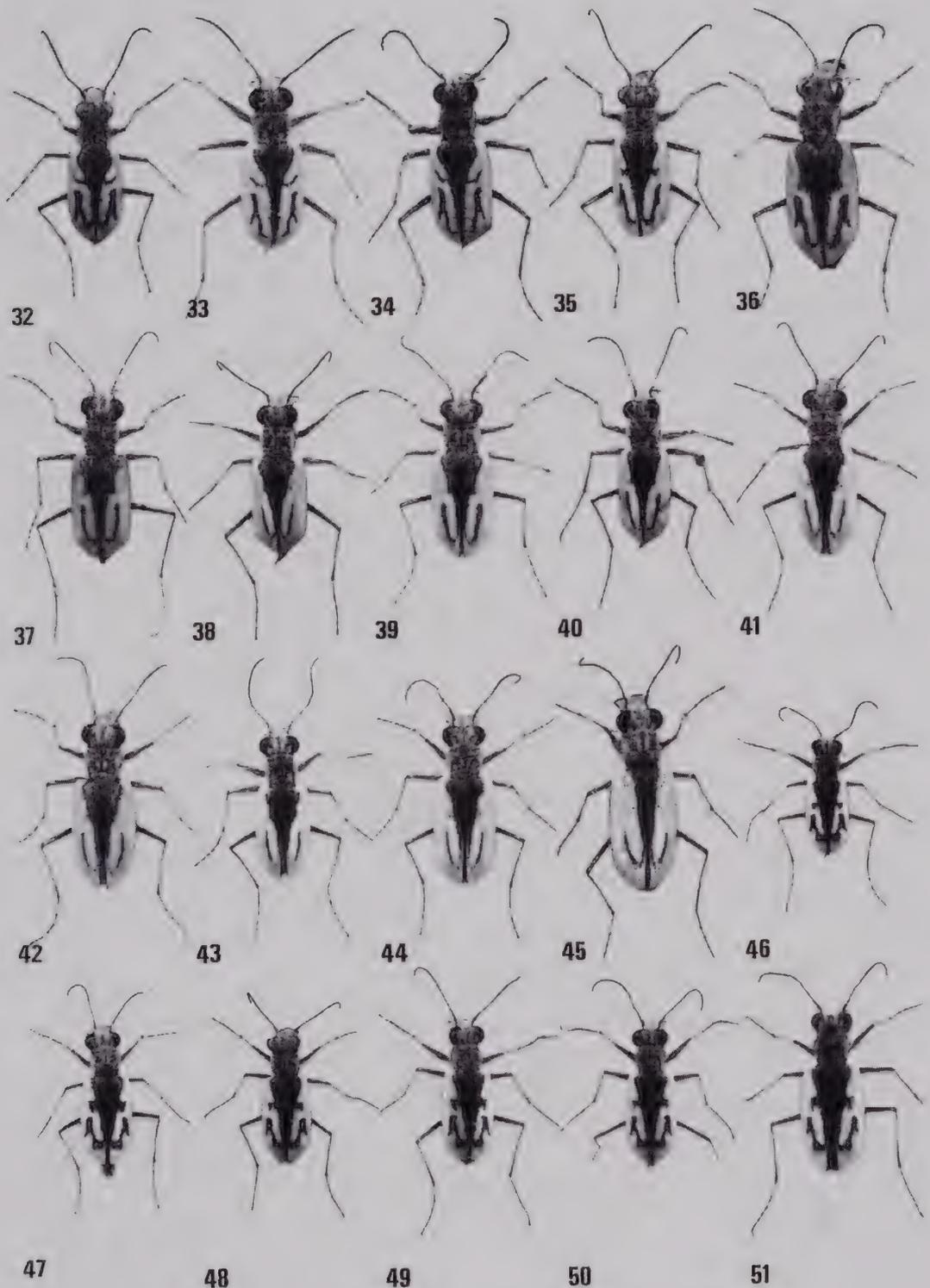
Table 1. Continued

Locality	Date & No. of specimens	Specimen elytral markings		Sand samples
		Dark background marks	Colour	
Ninety Mile Beach, 20.7km N. of Hukatere	24.III.1988 -2	Very thin, reduced	Pale cream	Cream
Ninety Mile Beach, 25.1km N. of Hukatere	24.III.1988 -2	Very thin, reduced	Pale cream	Cream
Ninety Mile Beach, S. of The Bluff, Te Kao	22.III.1988 -2	2 very thin, reduced	Pale cream	Cream
	23.III.1988 -6	1 very thin, reduced 5 very thin, very reduced		
Ninety Mile Beach, S. side The Bluff, Te Kao, 30.5km N. of Hukatere	25.II.1988 -3	2 very thin, reduced 1 very thin, very reduced	Pale cream-very pale cream	Cream
Ninety Mile Beach, 0.5km N. of The Bluff, Te Kao	22.III.1988 -3	1 very thin, reduced 2 very thin, very reduced	Very pale cream	Cream
Ninety Mile Beach, Te Paki	24.II.1988 -16	3 very thin, reduced 13 very thin, very reduced	Very pale cream	Cream
Te Werahi Beach, SW. of C. Reinga	23.II.1967 -1	Very thin, very reduced		
	24.II.1988 -25	6 very thin, reduced 19 very thin, very reduced	Cream-very pale cream	Pale cream
Top of sand cliffs Te Werahi Beach, SW of C. Reinga	24.II.1988 -4	Very thin, very reduced	Pale cream	Yellow
Beach Kapowairua, Spirits Bay	23.II.1988 -31	1 very thin, reduced 30 very thin, very reduced (Inc. 3 very faint)	Pale cream-very pale cream	Whitish cream quartz + shell
Rarawa Beach, Ngataki	9.III.1967 -18	3 very thin, reduced 14 very thin, reduced 1 nil	White	(White)
	2.II.1973 -7	6 very thin, very reduced 1 nil	White	White
	29.II.1984 -5	Very thin, very reduced (Incl. 2 very faint)	White	
	14.I.1988 -12	3 very thin, reduced 8 very thin, very reduced (Incl. 2 very faint) 1 nil	White	White quartz (fine)
	23.III.1988 -15	8 very thin, reduced 7 very thin, very reduced (Incl. 1 very faint)	White	White quartz (fine)

Rarawa Beach, Ngataki	19.V.1988	-4	2 very thin, reduced 2 very thin, very reduced (Incl. 1 very faint)	White	White quartz	
On beach at edge of stream, Rarawa Beach, Ngataki	2.II.1973	-4	Very thin, very reduced	Discoloured	Dull white (discoloured)	
Beach N. of Kotiatia Pt N. of Rangiputa, Karikari Pen.	5.III.1976	-10	1 very thin, reduced 6 very thin, very reduced 3 nil	White	(White quartz) White quartz	
<i>N. brevilunata</i> (Horn, 1926) Beach Marsden Pt.	30.VI.1988	-0				
Beach Ruakaka	17.III.1968	-5	Thin	Dull white	Greyish-white	
	26.II.1988	-37	Thin	Dull white	Greyish-white	
	3.II.1988	-6	Thin	Dull white	Greyish-white	
	20.IV.1988	-6	Thin	Dull white	Greyish-white	
	3.II.1973	-9	Thin	Dull white	Greyish-white	
	2.I.1982	-7	Thin	Dull white	Greyish-white	
	25.III.1982	-8	Thin	Dull white	Greyish-white	
	12.I.1988	-5	Thin	Dull white	Greyish-white	
	3.II.1988	-9	Thin	Dull white	Greyish-white	
	20.III.1988	-13	Thin	Dull white	Greyish-white	
Beach Uretiti, N. of Waipu R.	20.IV.1988	-6	Thin	Dull white	Greyish-white	
	17.V.1988	-5	4 thin 1 very thin	Dull white	Greyish-white	
	22.VII.1988	-1	Thin	Dull white	Greyish-white	
	19.IV.1988	-8	7 thin 1 very thin	Dull white	Greyish-white (coarse)	
	19.IV.1988	-1	Thin	Dull white	Greyish-white (coarse)	
	12.IV.1988	-11	6 thin 5 very thin	Dull white (Some discoloured)	Greyish-white (coarse)	
	17.V.1988	-13	9 thin 4 very thin	Dull white (Some discoloured)	Greyish-white (coarse)	
	22.VI.1988	-2	Thin	Dull white	Greyish-white (coarse)	
	Beach N. end Waipu Cove					
	Beach Te Arai					
Beach Pakiri						



Figs. 12-31. *Neocicindela* spp. *N. perhispida*. Waikato R. Heads — Hukatere. 12,13. S. side Waikato R. Heads. 4.IV.1988. 12. ♂. 13. ♀. 14. Karekare. 1.II.1988. ♀. 15-20. Muriwai Beach. 15. 2.1 km N. of Muriwai. 5.IV.1988. ♂. 16. 4.7 km N. of Muriwai. 31.III.1988. ♂. 17. 6.2 km N. of Muriwai. 31.III.1988. ♂. 18. 9.1 km N. of Muriwai. 5.IV.1988. ♀. 19. 12.3 km N. of Muriwai. 31.III.1988. ♂. 20. 19.3 km N. of Muriwai. 16.III.1988. ♂. 21. S. of Chases Gorge, Bayllys Beach. 13.IV.1988. ♂. 22,23. Beach Waimamaku, S. of Hokianga Hbr. 5.II.1988. 22. ♀. 23. ♀. 24,25. Mitimiti, N. of Hokianga Hbr. 4.II.1988. 24. ♂. 25. ♀. 26-31. Ninety Mile Beach. 26. Ahipara. 8.II.1988. ♀. 27. Waipapakauri. 26.II.1988. ♂. 28,29. Hukatere. 25.II.1988. 28. ♂. 29. ♀. 30. Hukatere. ca. 3.6 km from beach. 25.III.1988. ♀. 31. 8.7 km N. of Hukatere. 24.III.1988. ♀.



Figs. 32-51. *Neocicindela* spp. 32-45. *N. perhispida*. Hukatere - Rarawa Beach. 32-41. Ninety Mile Beach. 32. 15.0 km N. of Hukatere. 24.III.1988. ♂. 33. 18.4 km N. of Hukatere. 25.III.1988. ♂. 34-36. 19.8 km N. of Hukatere. 24.III.1988. 34. ♂. 35. ♂. 36. ♀. 37. 20.7 km N. of Hukatere. 24.III.1988. ♂. 38. 25.1 km N. of Hukatere. 24.III.1988. ♂. 39. S. side The Bluff, 30.5 km N. of Hukatere. 25.II.1988. ♀. 40. 0.5 km N. of The Bluff. 22.III.1988. ♂. 41. Te Paki. 24.II.1988. ♂. 42. Te Werahi Beach. 24.II.1988. ♀. 43,44. Kapowairua, Spirits Bay. 23.II.1988. 43. ♂. 44. ♀. 45. Rarawa Beach. 23.III.1988. ♀. 46-51. *N. brevilunata*. Marsden Pt.-Pakiri. 46,47. Marsden Pt. 26.II.1988. 46. ♂. 47. ♀. 48. Ruakaka. 20.IV.1988. ♀. 49. Uretiti. 20.III.1988. ♂. 50. Beach Te Arai. 19.IV.1988. ♂. 51. Pakiri. 12.IV.1988. ♀.

North Island west coast beaches, as at Kawhia and Waikato River heads (Fig. 57), are black from the presence of ironsands which continue on several west coast beaches north of the Manukau Hbr. as far as the south end of Muriwai Beach. The dark *campbelli* colour pattern on tiger beetles occurs there but it is now seen that as the black sands thin out and become patchy northwards along this beach the tiger beetle black background marks become thinner and the creamy colour area becomes more extensive. The trip meter of a vehicle, driven northwards along the beach from the southern entrance, was used to measure the kilometres as far as 16.4 km. Another entrance was used at 19.3 km and specimens there were of the *perhispidata* pattern. North of the Kaipara Hbr. the *perhispidata* pattern is continued northwards on cream sands to Ninety Mile Beach except for the Waimamaku beach, south of Hokianga Hbr. There (Waimamaku), both cream and whitish cream sands occur and tiger beetle specimens show a range of reduction of the dark marks to the *giveni* pattern combined with a very pale colour. North of the Hokianga Hbr. a long beach of pale cream sand extends beyond Mitimiti (Fig. 56) where specimens have a very thin but complete *perhispidata* pattern. Beaches further north on the same coast have varied sands and again there are reductions in the dark marks on specimens.

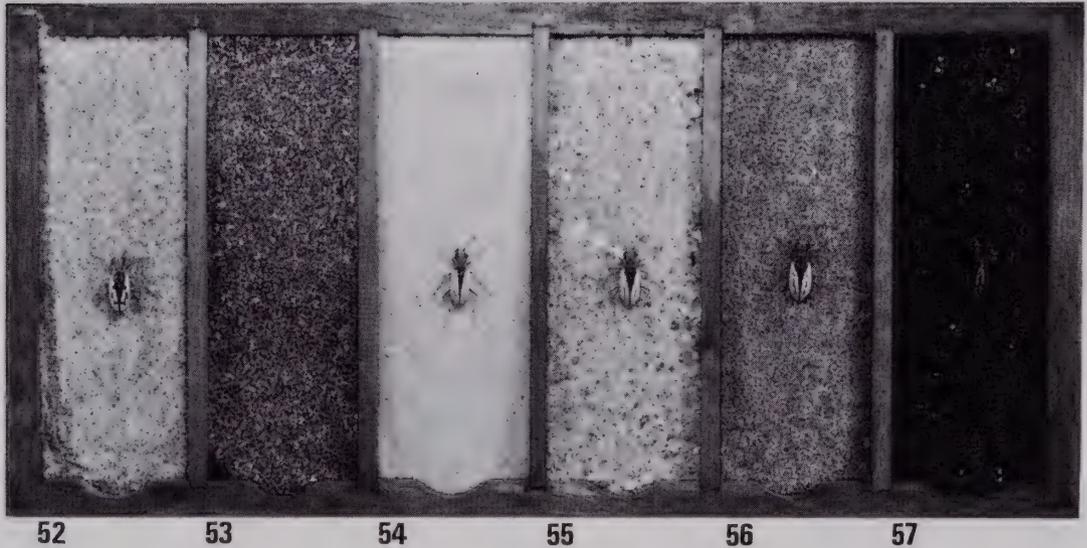
Ninety Mile Beach (actually ca. 90 km long) extends along the west coast of the narrow northernmost peninsula of the North I. There are only a few direct access points which are indicated here by the name of the district behind them. From Ahipara at the south end to Hukatere, sands are dark cream and specimens have the *perhispidata* pattern. After investigations in that area and on the far northern coast it was found that the *giveni* pattern occurred on tiger beetles at Te Paki and the Bluff, towards the northern end of Ninety Mile Beach. Subsequently the trip meter of a vehicle was used to measure distances of collecting places along the beach from Hukatere to The Bluff, 30.5 km to the north, where only the *giveni* pattern was found. At Te Werahi Beach, further north, dark marks are somewhat variable and colour is darker on some specimens. Although the beach fore-dune sand is pale, there is an outcrop of yellow sand on cliffs behind the beach. The same mustard yellow sand occurs on the surface some 3.6 km inland from Hukatere and a yellowish-cream tiger beetle with typical *perhispidata* pattern has been collected there.

On the northern coast of the peninsula, in Spirits Bay, the beach at Kapowairua (Fig. 55) has very pale sands with small shell pieces and the elytral dark marks on specimens are very reduced and on some very faint with colour a very pale cream. From Parengarenga Hbr. south there are long beaches of glistening white quartz sand which extends to the tip of Karikari Pen. At Rarawa Beach (Fig. 54) and on the Karikari Pen. tiger beetles are clear white with the *giveni* pattern of dark marks — very reduced, very faint or absent (except for the sutural mark).

Beaches on the north-east coast of the North I., from east of Karikari Pen. (Fig. 53) almost to Whangarei Hbr. have pinkish-brown sand and, despite searches over many years, tiger beetles have not been found. On this coast there are also not the long beaches, or groups of beaches, as elsewhere in the area under consideration.

South of the Whangarei Hbr. on the east coast, long whitish beaches stretch southwards from Marsden Point (Fig. 52) to Pakiri but the sand has a different

appearance from white sand in the far north. Tiger beetles have a uniform dull white colour and the *brevilunata* pattern of dark marks.



Figs. 52-57. Sand and tiger beetles. 52. Marsden Pt. Specimen with "*brevilunata*" pattern. 26.II.1988. ♀. 53. Taipa, east of Karikari Pen. Tiger beetles absent. 54. Rarawa Beach. Specimen with "*giveni*" pattern. 23.III.1988. ♀. 55. Kapowairua, Spirits Bay. Specimen with "*giveni*" pattern. 23.II.1988. ♀. 56. Mitimiti. Specimen with "*perhispidata*" pattern. 4.II.1988. ♀. 57. South side Waikato R. Heads. Specimen with "*campbelli*" pattern. 4.IV.1988. ♀.

#### *Coastal sand-dunes and sand appearance*

In the areas of the North I coast-line where tiger beetles have been collected the beaches are usually backed by a line of fore-dunes up to ca. 10 m high, occasionally higher.

On the southern west coast where ocean drift has brought black ironsands from further south, winds may have drifted sands inland. While the beaches may be very black, sand on the surface of dunes may be lighter with the ironsands in windrows, patches or hollows. The beach on the south side of the Waikato River mouth (Fig. 58) extends along a sandspit with low dunes and patches of lighter and darker sands. At Muriwai Beach a line of fore-dunes is much darker at the south end and the sands gradually become paler northwards, with the ironsands patchy. Beyond ca. 12 km from the south end, sands are distinctly lighter in colour being a more uniform dark grey. However, the sand inland is whiter. The part of Muriwai Beach ca. 8.5-10.7 km north is west of Woodhill and is the area described by Walker (1904) as being of "clean white sand". Most of this area behind the beach is now covered in pine forest.

From Baylys Beach northwards sands are dark cream to cream in colour which arises from the presence of orange-coloured pieces in the sand. At Baylys Beach there are only low sand-dunes or a sand bank (ca. 2-3 m high) at the foot of cliffs but south of Maunganui Bluff there are open low sand-dunes. There are low dunes at the Waimamaku beach (Fig. 59), beside and north of the river, with variations in the sand. Much is a creamy colour but there are areas of whitish cream sand being partially of coarse clear grains. At the North Head of Hokianga Harbour very high (over 153 m) exposed sand-dunes stretch northwards between the harbour and the sea but at Mitimiti further north there is only a line of low dunes of pale cream sand. Sand-hills at Tauroa Peninsula are again very high (over 153 m) sloping down to low dunes at beach level.

From Ahipara northwards along Ninety Mile Beach sand-dunes are low and the sand is dark cream as far as Hukatere. The sand then gradually becomes paler and is noticeably paler at The Bluff (30.5 km to the north) and paler again at Te Paki near the north end of Ninety Mile Beach.

At Hukatere there is pine forest up to 5 km from the beach but in clearings a mustard yellow sand occurs with harder more compact outcrops containing dark brown veins. A similarly coloured stratum is obvious high in coastal sand cliffs at Baylys Beach and at The Bluff. It also occurs in cliffs at Te Werahi on the north-western coast where it has contributed to the colour at the top of the cliffs and on sand flats below.

The fore-dunes at Te Werahi are very low and the sand is pale cream. On the extreme northern coast in Spirits Bay, the fore-dunes are very low and the sand at Kapowairua (Fig. 60) is very pale cream with windrows and patches of small polished white shell pieces.

At Rarawa Beach there is a line of fore-dunes of a very fine glistening white quartz sand. The sand is the same in a small bay on the north-west point of Karikari Pen. where it is banked up a little at the top of the beach.

South of the Whangarei Hbr. a line of fore-dunes stretches from Marsden Pt. (Fig. 61) to Ruakaka, Uretiti and, south of the Waipu River, Waipu Cove. The sand is greyish white, with elongate black pieces, as it is further south at Te Arai and Pakiri where there is a line of very low fore-dunes.

#### *Sand composition on northern coasts*

It is an interesting chance that almost continuous beach and dune sands of the northern North I show a range of colours from black ironsands on the southern west coast through light coloured sands to white glistening quartz sands on the far northern east coast.



59



61



58



60

Figs. 58-61. Beaches. 58. South of Waikato R. Heads (S. end). 59. Waimamaku, S. of Hokianga Hbr.  
60. Kapowairua, Spirits Bay. 61. Marsden Pt., looking south to Ruakaka (far left).

The black ironsands apparently derive from the Taranaki andesites of Mt Egmont (Williams 1974: 135) and have been drifted northwards by coastal sea currents as far as Muriwai Beach west of Auckland (Schofield 1970, Williams 1974). Nicholson & Fyfe (1958) recorded the magnetically separable ironsand concentrations along that coast. While there are variations in the percentages at various localities there is a distinct drop along Muriwai Beach from 10% 3.2 km (2 miles) north of Muriwai to 2% at 4.8 km (3 miles) and less than 1% 6.4-48.2 km (4-30 miles) north.

J.C. Schofield, in his paper on coastal sands of Northland and Auckland (Schofield 1970), presented data for the coastal areas under consideration in the present study. In general, coastal sands from Waikato River area have high mafic content (which includes black ironsands), low quartz and medium residue (mainly rock fragments) percentages (ibid. Table 1). On Muriwai Beach there are high mafics, low quartz and low residues at the south end; medium values for mafics and quartz, low for residues towards the north (ibid. Table 3, Fig. 6). Further north to Hokianga and North Cape (ibid. Tables 4,5) there are some increases in quartz with mafics and residues remaining low, including a further quartz increase at Spirits Bay on the extreme north coast (ibid. Table 5). South of Parengarenga Hbr. on the far northern east coast the quartz percentages are very high (over 90%) and only a little less southwards to Karikari Pen., with almost no mafics or residues (ibid. Table 5, p.795). There is a major change east of Karikari Pen., the north-east coast is typified by low-medium quartz, low mafics and medium-high residue content (rock debris) which accounts for the pinkish-brown colour of the sands (ibid. Table 6, p.798). From the Whangarei Hbr. area south to Pakiri there is another major change with the occurrence of greyish white sands. Percentages of quartz are low-medium, mafics and residues are low but soda-calc feldspars, which elsewhere are mostly low (occasionally low-medium), are here high being over 60% (ibid. Table 7, p.804).

The sands of the northern coast-line thus show both gradual changes and distinct compositional differences in areas of interest in this study.

#### COASTAL TIGER BEETLES

##### *Local and seasonal activity*

Coastal tiger beetles occur on sand-dunes behind ocean beaches on northern North I coasts. In the summer season they are typically active on the front of fore-dunes and forage at the top of beaches. However, they are often more common beside beach entrances and stream banks where streams debouch through the dunes. Presumably these breaks in the dunes allow off-shore breezes, even if light airs, to carry a food supply of small insects to the dune banks and the streams supply flying aquatic insects. Tiger beetle colonies are able to tolerate human activity even on frequently used beaches where active beetles are sometimes seen between groups of picnickers. Permanent habitation along beaches may, however, affect colonies.

The greatest restriction for tiger beetle colonies appears to be vegetation. Behind many ocean beaches there are now farm pastures or pine forests. On the dunes, vegetation such as marram grass is further restricting the open sand spaces where tiger beetles run. They often fly out from cover and drop onto open sand to forage. The flight and run are typically quick and short, and are interspersed with motionless pauses.

These beetles fly actively in the sun but disappear suddenly if a cloud obscures it. However, they can be active in times of more diffuse light such as late in the afternoon or when a thin sheet of cloud is present.

At Pakiri, late in the season, they were found around the edges of damp sand flats behind dunes (where there were dense concentrations of small flies). Elsewhere they can occur on the backs of fore-dunes or in sheltered hollows.

*Seasonal.* Specimens do not seem to have been taken earlier than December but this may not represent the earliest for coastal tiger beetle activity in a summer season.

Previously the latest activity noted after the summer season was a group of specimens collected at Pakiri on 1 April 1961 by J.C. Watt and specimens taken at Bethells beach by the author on 1 April 1969.

Towards the end of the 1987/88 summer season, in early March 1988, Tropical Cyclone Bola caused havoc in the North I as it moved southwards and both east and west coasts were affected. Fore-dunes were wave-cut and subsequently much wind-blown loose sand was deposited on frontal dunes. While tiger beetles were still active later in March and early April few have been seen since. Gales have caused further wave-cutting and have covered parts of fore-dunes with sand to over 30 cm in many places, which may have affected the season for beetle activity. During the March-April period it was noticeable that tiger beetle activity was almost entirely behind the fore-dunes.

The first visit made by the author to Pakiri on the east coast was on 12 April 1988, when tiger beetles were still active around the edges of damp sand flats (occasionally flooded) behind the low dunes. The next day one was taken at Baylys Beach on the west coast but there were none further north. In the far north no tiger beetles have been seen on Ninety Mile Beach in April, May, June or July and the last four at Rarawa Beach were seen on 19 May.

Some tiger beetles were active between Te Arai and Ruakaka on the east coast in late April and at Pakiri and Uretiti on 17 May. Three were seen at Pakiri on 22 June but none later in June at Uretiti, Ruakaka, Hukatere or Rarawa beaches. None were seen at Hukatere or Rarawa later in July but one individual was found moving slowly on the sand at Uretiti on 22 July 1988.

### Colours

Colours which may be seen from the front or above are basically the dark ground-colour (dark marks) and the paler colour markings. However, strong white setae scattered over the head, basal antennal segments, thorax, legs and the wide basal area of the sutural streak on the elytra partially obscure these dark areas and give them a more or less paler appearance.

*Labrum*. This is pale, similar to the elytral colour, with sometimes small brown spots, at the bases of prominent setae across the middle, and always with a short brown median tooth distally.

*Head and thorax*. Both are dark, the black ground-colour usually with more or less reddish or greenish metallic sheen.

*Antennae and legs*. Two basal segments of the antennae and femora of the legs are dark. Antennal segments 3 and 4 are pale as are the tibiae of the legs. The remaining antennal segments distally are dark as are the distal ends of the tibiae and the tarsal segments. The whole effect is to break up the outline around the body.

*Elytra*. The dark ground-colour is basically black (as it appears macroscopically) often with reddish metallic sheen (seen more when magnified under bright light) and with many metallic green spots which are mostly blue-centred. The background colour of the dorsum (thorax and elytral dark marks) varies in appearance with light and magnification. However, east coast *Neocicindela brevilunata* show the reddish sheen more. West coast "*perhispida*" and northern "*giveni*" show more green with the greenest being from Ahipara on Ninety Mile Beach. The darker "*campbelli*" show as a dull black.

Elytral colour of west coast specimens is mostly in shades of cream but can be more or less yellowish. Specimens from the far north coast are very pale cream in colour and from the adjacent east coast are clear white. On specimens from Marsden Pt. southwards on the east coast the colour markings are dull white. There are occasional small dark spots on the pale areas (of specimens from any coast), particularly basally and apically, and sometimes a dusting of fine spots over the whole pale colour area.

### Elytral markings

The description of *perhispida* by Broun (1880) is simple as he recognised the dark groundcolour was reduced so that the dark marks represented the form of an anchor. His description of *campbelli* (Broun 1886), however, is a complete contrast as he described the pale colour pattern which made for a complicated description.

The same difficulty was found by Horn (1926b) who gave a latin description of the colour pattern for *brevilunata*, then explained the colour patterns of *campbelli*, *perhispida* and *brevilunata* in the following text, but he made a distinction between the last two clear by turning to the form of the dark marks in his last sentence.

Consequently the anchor analogy is used here for the sake of simplicity. The form is a stylised pick anchor with two curved flukes at the distal end of a shaft, and a cross stock towards the inner end (but necessarily transverse in the same plane as the flukes).

*The Neocicindela perhispidata pattern* (Figs. 12-45). The basic pattern of dark marks on *perhispidata* specimens, on light-coloured sands from the northern west coast of the North Island (Muriwai to Ninety Mile Beach), is of anchor form. The shaft lies on the elytral suture and is widest near the base tapering sharply to the stock then continuing to about three-quarters. From the terminal end of the shaft the base of each fluke is curved beyond the end of the shaft then straightens anteriorly to the point which is recurved (hooked) more or less postero-laterally; the point is pointed or thinly truncate and the postero-lateral extension usually elongate. The stock is thin and transverse basally with thinning distal extensions angled antero-laterally.

The darker *campbelli* pattern can be seen to be a thickening of the *perhispidata* pattern, together with extension of the stock to (or almost to) the lateral edges, on specimens taken further south (from Muriwai) getting darker on the darker ironsands southwards. At the type locality (Waikato Heads) the thick-lined anchor form can still be seen but further south at Kawhia the pattern is darkened more by the presence of a dark streak along the lateral edges joining the fluke and the transverse stock on each side.

Conversely, the *giveni* pattern (recorded by van Nidek 1965), on specimens from pale or white sands in the far north, is seen to be a reduction of the thin *perhispidata* pattern with a loss of the transverse stock and the flukes represented by only two short curved lines or also entirely lost.

The intermediate areas between these three pattern forms are two long beaches, Muriwai Beach in the south and Ninety Mile Beach in the north. At the south end of Muriwai Beach, where ironsands still occur, the dark pattern is thicker as in *campbelli* but as the ironsands diminish the pattern also gradually changes and dark marks thin out into the *perhispidata* pattern 10-20 km to the north. On Ninety Mile Beach the *perhispidata* pattern continues to Hukatere but reduces as the sand gets paler between there and the Bluff 30.5 km to the north. The *perhispidata* marks gradually thin then reduce into the *giveni* pattern 19-26 km north of Hukatere.

While these gradual progressive changes can be seen, they are not absolute and occasional specimens on both sides of the immediate change zone can show tendencies to the patterns of the other side. At Waimamaku beach, south of Hokianga Harbour, specimen patterns are quite variable and the *giveni* forms are present there, a long way (ca. 90 km) south of the actual change zone.

As *perhispidata* is so variable the stock (median dark transverse bar) is often reduced, particularly at the base which makes it even less like the stock of *brevilunata*. There are just a very few specimens (2 or 3) seen so far where the stock is reduced distally (see Fig. 35), somewhat approaching the form of the short truncate stock of *brevilunata*, but on these specimens the distal flukes remain distinctly of the *perhispidata* form.

The overall picture is that there is one continuous series of patterns starting with the almost entirely black pattern, on the southern west coast ironsands, which lightens on paler sands to the north and which almost entirely disappears on the palest sands of the most northern beaches and the white sands of the east coast far northern beaches.

*The Neocicindela brevilunata pattern* (Figs. 46-51). This occurs on specimens from east coast localities south of the Whangarei Harbour. It is a bold anchor pattern with the shaft tapering evenly to the distal end. The base of each fluke is broad with a postero-lateral angle so that the two together give the appearance of a straight transverse band. Each fluke thins anteriorly before the point which is recurved (hooked) postero-laterally; the point is broadly truncate and the postero-lateral extension is short. The transverse stock is short, broad and truncate with a slight posterior extension distally on each side, the whole straight distal edge slightly angled inwards towards the posterior.

A slight variation sometimes seen in *brevilunata* is also in the stock where the base is thickened posteriorly, tending to fill in the space to the distal posterior extension so that the whole appears thicker and even more unlike the stock of *perhispidata*.

### Sizes

The median lengths (front of head to tip of elytra) fall within the same range for the two species except for a few larger females. Ranges given here are from a selection of specimens taken at different localities.

Lengths. *Neocicindela perhispidata* ♂♂ 8-9.5 mm ♀♀ 9-10.5 mm.

*Neocicindela brevilunata* ♂♂ 8-9.5 mm ♀♀ 9-10.0 mm.

### Consideration of species and subspecies

Freitag (1979) in considering Australian *Cicindela* species stated that characters used for identification are pubescence, coloration and shapes of sclerites or appendages and the genitalia of females. He also considered that body and appendage colour and colour pattern are most important in distinguishing species, including the shapes of markings on the elytra. The criteria used for the separation of species and subspecies were also given. Freitag indicated that a distinct difference in any one character was sufficient to distinguish between them.

The New Zealand species under discussion here, under the names of *Neocicindela perhispidata* (Broun, 1880) and *N. brevilunata* (Horn, 1926), are clearly allopatric and separated by distinct differences in the elytral patterns. However, the previously recognised three subspecies of *N. perhispidata* are here shown to be one continuous series with elytral pattern varying according to sand colour. Consequently, it is considered here that they are not true subspecies and the previous subspecific names are used as pattern or varietal names only.

Freitag (1979) used female genitalia for *Cicindela* species but they are all of very similar form. Rivalier (1963) figured the male genitalia of one New Zealand species but mainly to demonstrate generic differences. Genitalia of a few specimens of northern coastal tiger beetles have been examined superficially but no obvious differences were seen and they are not considered further within the scope of this paper.

#### NOMENCLATURE

The two northern species of coastal tiger beetles (Coleoptera:Cicindelidae) are listed with synonymic lists of references of importance in nomenclature. Specimens in overseas collections, examined recently by the author, are all included, with the addition of type specimens of *Neocicindela perhispidata giveni* in New Zealand.

In view of the extensive collections recorded above (Table 1) it is not felt necessary to record all specimens held in New Zealand collections as they are readily available and all those seen confirm the observations made.

#### *Abbreviations for collections*

BMHN(Broun)	— Broun Collection in British Museum (Natural History), London.
BMNH(Ent)	— Main Entomology Collection in British Museum (Natural History), London.
BPBM	— Bernice P. Bishop Museum, Honolulu.
ATIE(Horn)	— Horn Collection in Abteilung Taxonomie der Insekten, Institut für Pflanzenschutzforschung, Eberswalde (previously Deutsches Entomologisches Institut).
MNHN	— Muséum National d'Histoire Naturelle, Paris.
NZAC	— New Zealand Arthropod Collection, Entomology Division, D.S.I.R., Auckland.

In the following specimen data, separate labels are indicated (by a stop and space) wherever possible and numbers of specimens are given in brackets where necessary.

Genus *Neocicindela* Rivalier, 1963

*Neocicindela* Rivalier, 1963 *Rev. franç. Ent.* 30(1):36.

*Neocicindela perhispida* (Broun, 1880)

*Cicindela perhispida* Broun, 1880, *Manual N.Z. Coleoptera*, 4.

*Cicindela campbelli* Broun, 1886, *Manual N.Z. Coleoptera*, 817.

*Cicindela perhispida* var. *horni* Horn, 1892, *Deutsche Ent. Zeitschr.* 1892: 97.

*Cicindela perhispida* var. *brouni* Horn, 1893, *Deutsche Ent. Zeitschr.* 1893: 336.

*Cicindela campbelli*: Horn, 1896, *Stett. Ent. Ztg.* 57: 171 (*C. perhispida* var. *brouni* Horn, 1893, as syn.).

*Cicindela perhispida*: Horn, 1915, *Genera Insectorum* Fasc. 82c: 319.

*Cicindela campbelli*: Horn, 1915, *Genera Insectorum* Fasc. 82c: 319.

*Cicindela perhispida campbelli*: Horn, 1936, *B.P. Bishop Mus. Occ. Pap.* 12 (6): 11 (*C. campbelli* Broun, 1886, as subspecies).

*Neocicindela perhispida*: Rivalier, 1963, *Rev. franç. Ent.* 30 (1): 37.

*Neocicindela perhispida campbelli*: Rivalier, 1963, *Rev. franç. Ent.* 30 (1): 37.

*Neocicindela perhispida perhispida*: van Nidek, 1965, *N.Z. J. Sci.* 8:353.

*Neocicindela perhispida campbelli*: van Nidek, 1965, *N.Z. J. Sci.* 8: 353.

*Neocicindela perhispida giveni* van Nidek, 1965, *N.Z. J. Sci.* 8: 353.

“*perhispida*”

BMNH(Broun). New Zealand Broun coll. Brit. Mus. 1922-482. Type. ♂. 9. Whangarei.  
*Cicindela perhispida*.

The type label (printed in red) may have been added at BMNH. “9” is Broun’s species number for this species. Whangarei is not a collecting locality. This is the only Broun specimen of the west coast species remaining in the BMNH collections but could not be a syntype if it did not come from Hokianga.

MNHN. New Zealand Broun coll. Brit. Mus. 1922-482. Marsden Point ♂. Museum Paris Ex Coll. M. Maindron. Coll. G. Barbault 1930.

This also is typical of the west coast species and could not have been collected at Marsden Pt. MNHN received the Barbault collection which included the collection of Maindron who would have received the specimen from BMHN.

BMNH(Ent). Woodhills Auckland New Zealand 21 Jan 02. New Zealand J.J. Walker 1905-96. *Cicindela perhispida* Broun (4). Woodhills New Zealand J.J. Walker bequest 1939. Brit. Mus. 1948-129. *Cicindela perhispida* Broun E.B. Britton det. 1946 (2).

These specimens have thicker dark marks tending towards the *campbelli* pattern.

N. Zealand H. Swale 1913-117. 1182 (2). N. Zealand H. Swale 1913-117. 1176 (1).

The “1182” specimens have thicker dark marks tending towards *campbelli*.

New Zealand G.C. Champion Coll. B.M. 1927-409 (4).

These are also specimens with slightly thicker dark marks.

90-mile Beach N. Auck. 11.1.27 A.R. 90 Mile Beach Mangonui 11.1.27. A Richardson. New Zealand C.E. Clarke Collection B.M. 1957-24 (4). Ninety-mile Beach N. Auck. 11.1.27 C.E.C. New Zealand C.E. Clarke Collection B.M. 1957-24. 90 mile beach C.E. Clarke (2).

BPBM. Woodhills NZ 1902 J. Walker. *Cicindela perhispidata* Broun (3). [No data.] *Cicindela perhispidata* (2).

These specimens are typical *perhispidata*.

ATIE(Horn). Woodhills NZ 1902 J.J. Walker. Sharp Coll.1905-313. New Zealand. Brit. Mus. Coll. W. Horn. DEI Eberswalde (1). Woodhills N.Z. 1902 J.J. Walker, Sharp Coll. Brit. Mus. Coll. W. Horn DEI Eberswalde (1).

Neú Seeland Nord Insel. Kaipara Harbour bei Hobianga det. Brooks 1935. Coll. W. Horn DEI Eberswalde (3).

Apart from mis-spelling, one handwritten label on each specimen indicates Kaipara Harbour near Hokianga determined by Brookes in 1935.

#### *"campbelli"*

BMNH(Broun). New Zealand Broun coll. Brit. Mus. 1922-482. New Zealand. 1451. ♀.

"1451" is Broun's species number for *campbelli*. This is the only specimen in BMNH collections which could be a syntype of that species and it is typical of the southern ironsands area of the northern west coast.

New Zealand Broun coll. Brit. Mus. 1922-482. Manukau. ♂. *Cicindela campbelli*. Also a dark specimen from west coast ironsands.

BMNH(Ent). N. Zealand H. Swale 1913-117. 1183.

This specimen has the typical *campbelli* pattern (see also note to Swale specimens recorded above under *perhispidata*).

New Zealand Broun Coll. Brit. Mus. 1922-482. Manukau. 145k. ♀ (1). New Zealand Broun Coll. Brit. Mus. 1922-482. Kerikeri 23.2.1916. 1451 ♂. *C. perhispidata campbelli* Broun R.D. Pope 1972 (1).

The present author has added a note to the last specimen "West coast subsp. on black ironsands. Locality prob. Karekare, nr. Auckland", as Kerikeri is in the east coast area where coastal sand-dune tiger beetles do not occur (Fig. 11).

New Zealand C.E. Clarke Collection B.M. 1957-24. Muriwai Beach 5.3.27 *C. campbelli* (1). New Zealand C.E. Clarke Collection B.M. 1957-24. Piha 1.1.34 (1).

MNHN. Museum Paris Nouv. Zelande H. Deyrolle 1885. 85. *campbelli* Brn var Horn 96. èdèage 1942 Rivalier. *perhispidata campbelli* Broun.

This specimen has an aberrant (or stained) *campbelli* pattern.

Waikato. Museum Paris. Nlle Zelande 1912 Th. Broun. èdèage 1918 Rivalier.

ATIE(Horn). Reisch.1981 Neuseeland ex coll. Wien Mus. Type! Dr W. Horn. Syntypus. Coll. W. Horn DEI Eberswalde.

This specimen is in the collection as *C. brouni* Horn but Horn (1893) used the name *brouni* for a variety (of *C. perhispidata*) which he subsequently (1896) synonymised with *campbelli*. It is a large "*campbelli*" typical of the coast from Waikato Heads northwards. The label "Reisch. 1891. Neuseeland" is printed and presumably indicates the Reischek collection deposited in the Vienna Museum in 1891. Andreas Reischek was an Austrian who made large natural history and ethnological collections in New Zealand between 1877 and 1889 (see King 1981).

Neu Seeland. Coll. W. Horn DEI Eberswalde (1). coll. V de Poll. Coll. W. Horn DEI Eberswalde (1). Karekare W. Coast Auckland New Zealand. Coll. A.E. Brookes 12.2.1916. *Cicindela campbelli* Broun Identified by A.E. Brookes. Coll. W. Horn DEI Eberswalde (1). Port Waikato W. Coast (N.Z.) T. Cockcroft 27.XII. 1925. Coll. W. Horn DEI Eberswalde (2).

Waikato Heads Haireburn 10.1.32. Coll. W. Horn DEI Eberswalde (7). Karekare Beach Auckland [?] Hairburn 1.32. Coll. W. Horn DEI Eberswalde (3).

Collectors names on handwritten labels are errors for Fairburn. There are still four specimens in the E. Fairburn collection, taken by Fairburn himself; two from Waikato Heads on 10.1.32 and two from Karekare on 12.1.32.

"*giveni*"

NZAC. Spirits Bay, 10.1.57, B.B. Given. Holotype. *Cic. perhispidata giveni* n.s.sp. Det. C.v. Nidek. Spirits Bay, 10.1.57, B.B. Given. Allotype. *Cic. perhispidata giveni* n.s.sp. Det. C.v. Nidek.

There are also paratypes with the same data in NZAC but none were seen in BMNH.

BMNH(Ent). Spirits Bay 11.1.1957 R.A. Cumber Coll. B.M. 1985-344 (2).

Typical *giveni* taken the day after the types.

*Neocicindela brevilunata* (Horn, 1926)

*Cicindela brevilunata* Horn, 1926, *Ent. Blätt.* 22 (4): 168.

*Cicindela perhispidata* Horn, 1915, *Genera Insectorum* Fasc. 82c, pl.18 fig.9 (nec Broun, 1880).

*Cicindela brevilunata* Horn, 1926, *Ent. Blätt.* 22(4): 168 (*C. perhispidata* Horn, 1915, Pl.18 fig.9, as syn.).

*Neocicindela brevilunata*: Rivalier, 1963, *Rev. franç. Ent.* 30 (1): 37.

*Neocicindela brevilunata*: van Nidek, 1965, *N.Z. J. Sci.* 8: 353.

BMNH(Ent). New Zealand. Sharp Coll. 1906-313. [?]. Broun. Type. "*Cicindela albohispidata* or *perhispidata*". *Cicindela brevilunata* type ♀ W.H. Dr. W. Horn det 1926.

This is presumably a Broun specimen sent to Sharp and later received at BMNH. The type label (printed in red) may have been added at BMNH. This specimen should be considered as the primary type as it was the first of the three specimens recorded by Horn (1926b) and, besides various printed type labels on the three specimens [see also below under ATIE(Horn)], it is the only specimen bearing a personal label as "Cicindela brevilunata type ♀ W.H." It is typical of this east coast species.

51604. Broun. Type. Nov.Zel. Fry Coll. 1905-100. *Cicindela perhispidata* Broun N. Zealand Type. (Fry catalogue: 51604 *Cicindela perhispidata* Broun Man. N.Z. Col. p.4 Type New Zealand Auckland (9) Capt. Broun. BMNH Catalogue: 1905-100 Fry Collection).

This appears to be an original specimen of *Cicindela perhispidata* Broun sent to Fry. It is a typical east coast specimen but was not recorded by Horn (1926b) and is not a type of *brevilunata*.

Ruakaka Beach E. coast N.Is. N. New Zealand. 13.12.1951 A.E. Brookes. *Cicindela brevilunata* Horn Det. A.E. Brookes. Brit. Mus. 1952-526 (2).

ATIE (Horn). Hokianga. New Zealand Broun Coll. Brit. Mus. 1922-482. Syntypus. Typus. Type! Dr. W. Horn. Coll. W. Horn DEI Eberswalde.

The "Hokianga" label is a printed one. There are also two labels handwritten in German, presumably by Horn. One starts with "1926" and states he was given the specimen by Arrow and that it is possibly the first specimen mentioned in the description by Broun or a specimen given to him later from the same locality. The other states that it is Broun's "Holotype" according to A.E. Brookes (NZ). It is the second specimen recorded by Horn (1926b). The specimen itself is in the collection as *C. brevilunata* Horn and, although the right elytron is damaged (apical three-quarters missing), the pattern on the left elytron is typical of the east coast species.

N. Zealand. Syntypus. Type W Horn. Coll. W. Horn DEI Eberswalde.

This, the third specimen recorded by Horn (1926b), is also clearly the east coast species.

Waipu N. Auckland New Zealand. Coll. A.E. Brookes 2.1.1914. Coll. W. Horn DEI Eberswalde (1). Waipu N. Auckland New Zealand. Coll. A.E. Brookes 2.1.1914. *Cicindela perhispidata* Broun Identified by A.E. Brookes. Coll. W. Horn DEI Eberswalde (1).

These would be the specimens mentioned by Brookes (1944).

Ruakaka Beach North Auckland N.Z. Coll. E. Fairburn 25.3.1932. Ruakaka Beach N. Auckland Fairburn 25.3.32. Coll. W. Horn DEI Eberswalde (1). Ruakaka Beach N. Auckland Fairburn 25.3.32. Coll. W. Horn DEI Eberswalde (13).

MNH. Museum Paris Nlle Zelande Th. Broun 1912 (2). Marsden Point near Whangarei N.Z. 29.1.24. Museum Paris Nlle Zelande P. Serre 1926. *Cicindela perhispidata* Broun (4).

These are typical *brevilunata*.

The difficulty in considering the nomenclature of *Cicindela perhispidata* Broun, 1880 and *C. brevilunata* Horn, 1926 is illustrated in Table 2. All five specimens listed for the former species are Broun specimens which are or have been in the British Museum (Natural History). Of the three listed for the latter species, two are Broun specimens which are listed also under the former species and one is not.

A specimen labelled "Hokianga" (on the west coast) was recorded in the original descriptions of both *C. perhispidata* by Broun (1880) and *C. brevilunata* by Horn (1926b). It seems likely that this is the same specimen as Horn (1936) acknowledged that it was from the Broun collection, although he stated there was no proof that it was

Table 2. Identity of specimens recorded in original descriptions of *Cicindela perhispidata* Broun, 1880 and *C. brevilunata* Horn, 1926, compared with specimens in collections

Recorded specimens		Specimens in collections		
		Collections	Specimen data	Present determination
<i>C. perhispidata</i> Broun, 1880				
Hokianga*	1 spec.	Broun/BMNH (Broun)/ ATIE (Horn)	Hokianga	Neocicindela brevilunata (Horn, 1926)
Marsden Pt	several	Broun/BMNH (Broun)/ Maindron/Barbault/ MNHN	Marsden Pt	Neocicindela perhispidata (Broun, 1880)
		Broun/BMNH (Broun)	Whangarei	Neocicindela perhispidata (Broun, 1880)
		Broun/Fry/BMNH	N Zealand	Neocicindela brevilunata (Horn, 1926)
		Broun/Sharp/BMNH†	New Zealand	Neocicindela brevilunata (Horn, 1926)
<i>C. brevilunata</i> Horn, 1926				
N Zealand	1 spec.	Broun/Sharp/BMNH†	New Zealand	Neocicindela brevilunata (Horn, 1926)
Hokianga*	1 spec.	Broun/BMNH (Broun)/ ATIE (Horn)	Hokianga	Neocicindela brevilunata (Horn, 1926)
N Seeland	1 spec.	ATIE (Horn)	N Seeland	Neocicindela brevilunata (Horn, 1926)

\*Presumed to be the same specimen. † The same specimen.

the original specimen. However, Horn determined the specimen he held as the east coast *C. brevilunata*. The specimen now in MNHN labelled Marsden Point is the west coast species, *perhispidata*. It is seen that there are specimens from both coasts incorrectly labelled. Dr J.C. Watt has advised (pers. comm.) that there are similar east coast/west coast errors known to him in the labelling (or recording) of other Broun Coleoptera.

Of the five Broun specimens, three are from the east coast (presently determined as *Neocicindela brevilunata*), two of them being conspecific with the third which was labelled by Horn as the type of *brevilunata*. The other two are the west coast species (presently determined as *Neocicindela perhispidata*) but are not original specimens of that species if they did not come from Hokianga, and only one specimen was so recorded by Broun (1880).

### Discussion

The range and distribution of colour patterns has been demonstrated above from specimens collected around northern North I coasts and the relationships have been considered in the section on specimens in overseas collections. The species presently accepted are *Neocicindela perhispidata* (Broun, 1880) of the west coast of the North I, extending around the far northern coasts to the far north east coast, and *Neocicindela brevilunata* (Horn, 1926) of the east coast south of Whangarei Hbr. It is seen that the *brevilunata* entity is clear as it has a type specimen so labelled by the author of the species name (Horn 1926b) and an excellent colour figure published by the same author (Horn 1915). Specimens (collected more recently) considered to be conspecific in colour and colour pattern are all from the east coast of the northern North I (south of Whangarei Hbr) where the species occurs on greyish-white sand of a particular composition (which differs from sands elsewhere on the North coasts examined).

However, the earlier *perhispidata* entity is confused by mis-labelling (mis-recording) of localities. It has always been accepted as the west coast species as the author of the species name (Broun 1880) included a reference to a west coast (Hokianga) specimen which he considered to be conspecific with other specimens from the east coast (Marsden Pt.). The only specimen now known to be labelled "Hokianga" was included by Horn (1926b) as a specimen of *brevilunata* and consequently appears to be a mislabelled east coast specimen. Other specimens from the Broun collection have been examined but none are dated so whether they were collected prior to the publication date (1880) cannot be determined. Several available specimens which earlier were considered as *perhispidata* are also now determined as the east coast species *brevilunata*.

If the two original descriptions are now re-examined in reference to the dark transverse median mark on the elytra (the anchor stock), it is found that the mark of *brevilunata* was described in the German text (Horn 1926b) as ". . . eine kurze, breite, horizontale Ausbuchtung." — a short, broad, horizontal excavation [in the pale colour]. Broun (1880) has described the ground colour dark pattern as ". . . an elongate triangular patch extending nearly to the apex, sending forth a short

transverse band near the middle . . .” It is considered by the present author that Broun had in fact described the east coast species from Marsden Pt. specimens. Consequently both Broun’s 1880 and Horn’s 1926 descriptions of the elytral marks were based on specimens of the same species. The taxonomic implications of these findings should be considered elsewhere.

#### CONCLUSION

Examination of coastal tiger beetle specimens of known locality from northern North I coasts, shows that two species can be easily recognised and separated by the colour and colour pattern of the elytra.

One variable species, currently known as *Neocicindela perhispidata* (Broun, 1880), occurs on sand-dunes from Kawhia up the west coast and around the northern coast to the far northern east coast as far south as Karikari Pen. The other species, which has little variation and is currently known as *Neocicindela brevilunata* (Horn, 1926), occurs on sand-dunes along the east coast beaches south of the Whangarei Hbr. from Marsden Pt. to Pakiri.

However, examination of specimens in early collections (which are largely not localised or dated, or which are labelled [or recorded] in error) together with original descriptions of the two species concerned indicates that the taxonomic situation is not clear and that the species need to be re-affirmed.

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